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(54) LASER WELDING METHOD FOR DIFFERENT METALS		(72) Inventor	Takeo Nishimoto % Hitachi Ltd., Mobara Plant 3300 Hayano, Mobara-shi
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SPECIFICATION

Title of the Invention

Laser Welding Method for Different Metals

Scope of Patent Claims

A laser welding method for different metals wherein a high-melting member to be welded composed of a high-melting thin plate or a high-melting wire such as tungsten or molybdenum is laser-welded to a base member to be welded composed of an iron plate, nickel plate or the like, said laser welding method for different metals characterized in that laser irradiation is performed from the side of said base member to be welded, thereby generating a melted flow of base member to be welded, and joining occurs when a nugget of said base member to be welded is formed at the periphery of a small hole formed in the thin plate or at the periphery of the wire of said high-melting member to be welded.

Detailed Description of the Invention

The present invention relates to a laser welding method, and specifically relates to a laser welding method for different metals that is used for welding high-melting wire or high-melting thin sheet such as tungsten or molybdenum with materials such as iron plate or nickel plate. In particular, the present invention relates to a laser welding method that is suitable for welding heater supports and heater coils that constitute electron tube negative electrode structures.

Negative electrode structures are produced by welding and assembling the coil connectors **2a**, **2a** of a heater coil **2** inserted inside a cathode **1** to protrusions **3a**, **3a** on a pair of heater supports **3**, **3**, as shown in Figure 1.

Conventionally, welding of coil connectors **2a** and heater supports **3** has generally been carried out by a resistance spot-welding method involving fixing the positions of the heater **2** and heater supports **3**, **3** using a holding jig (not shown), and then sandwiching the coil connector **2a** and heater support **3** with a pair of welding electrodes **4**, **5** while applying a pressure of a few kilograms, followed by supplying electricity generated at a power source **6** to the welding electrodes **4**, **5** via feeder wires **7**, thus causing resistance heating and welding of the coil connectors **2a** and protrusions **3a**.

However, in the negative electrode structure, the heater coil **2** is formed from small heaters produced by winding extremely thin wires of high-melting metal such as tungsten with an extremely thin wire diameter of 20 to 50 μm at a coil outer diameter of 0.1 to 0.2 mm and a coil pitch of about 0.1 mm. In addition, the heater support **3** is formed from nickel plate or iron plate with a plate thickness of about 0.2 mm, giving rise to the problems described below.

Specifically, because the material of the welding electrodes **4** and **5** is a soft conductive metal such as chrome copper alloy, it is heated by the heat generated at the member to be welded during welding. For this reason, the contact surface of the welding electrodes **4** and **5** experiences oxide film adhesion or ablation, and the initial welding conditions are not preserved. Consequently, it is necessary to change parts or repolish the material of the welding electrodes **4** and **5** to its initial condition within an allowed level of every 100 to 200 spot welds. In addition, because the contact resistance of the member to be welded at the time of welding is extremely small, and it is necessary to apply a pressure of 3 kg or greater, there is the undesirable effect that the heater coil **2** deforms.

These types of problems can be reconciled by the use of laser welding methods. However, when laser welding is carried out using the coiled wire described above along with a base member to be welded such as iron, the two types of metal are generally welded by laser irradiation from the side of the wire. Although this method prevents deformation of the heater coil **2** due to aforementioned pressure, the wire is deformed during welding as a result of fusion of the high-melting wire and iron plate. In addition, there is the disadvantage that the weld strength is decreased due to abnormal processes such as sputtering or boring.

An object of the present invention is to offer a laser welding method for various types of metals, whereby deformation of the parts to be welded can be prevented while maintaining weld strength.

An example of embodiment of the present invention is described below in reference to Figure 2. Because the negative electrode structure is constituted using the same configuration as in Fig. 1, designations **1** through **3** are the same and descriptions will not be presented. After positioning the heater **2** and heater support **3** using a holding jig (not shown), the coiled connector **2a** is pressed against the heater support **3** by means of a press plate **10**, and the coiled connector **2a** is firmly affixed to the heater support **3**. Next, a focused beam **11a** from the laser device **11** is used to irradiate the heater support **3** from the side of the heater support **3**, thereby performing welding. An escape hole **10a** is formed in the vicinity of the welding spot in the press plate **10**, thereby preventing fusion.

Because irradiation of the beam is carried out from the side of the heater support **3** in this manner, the heater support **3** is melted due to irradiation of the beam in the direction indicated by the arrow **A** as shown in Fig. 3, and the material flows towards the side of the coiled connector **2a**. The nugget **3b** of the heater support **3** thus encloses the coiled connector **2a** without deforming it, and diffusion joining occurs, allowing joint strength to be maintained. Disconnection occurred outside of the joint during tensile testing, and thus it was determined that sufficient joint strength was preserved.

Fig. 4 shows another example of embodiment of the present invention. The connector of the heater support **13** in this example of embodiment was produced in the form of a sleeve. Thus, when the heater support **13** formed in this manner was used, a nugget **13a** of the heater support **13** was formed as a result of laser irradiation so that the entire circumference of the coiled connector **2a** was enclosed, as shown in Fig. 5. Consequently, the mechanical strength of the joint was additionally improved. In addition, in this example of embodiment, a configuration was produced in which the heater support **13** sandwiched the coiled connector **2a**, and thus the side **13c** opposite the side **13b** that was irradiated with the focused beam **10a** also functioned as a press plate **10**.

Although the above examples of embodiment described connection of the heater coil of an electron tube negative electrode structure, the method of the present invention can be widely used in applications outside of heater coils in electron tube negative electrode structures. In addition, the method can be similarly used when the connector **2a** is not a coil, but a straight wire. In addition, when joining the high-melting thin plate and base material to be welded, a small hole can be processed into the high-melting thin plate, and a phenomenon may be utilized in which the melt flow of base material to be welded covers over the aforementioned hole.

As is clear from the above description, by means of the present invention, welding can be carried out without deforming the part to be welded while preserving joint strength.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is an oblique view of a conventional resistance welding method. Fig. 2 is a plan view of a example of embodiment of the laser welding method of the present invention. Fig. 3 is an enlarged cross section of the joint in Fig. 2. Fig. 4 is an oblique view showing another example of embodiment of the laser welding method of the present invention. Fig. 5 is an enlarged sectional view of the weld in Fig. 4.

2a	Coiled connector
3	Heater support
3b	Nugget
11	Laser device
11a	Focused beam
13	Heater support
13a	Nugget

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Figure 1

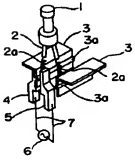

Figure 2

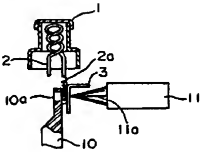

Figure 3

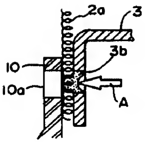

Figure 4

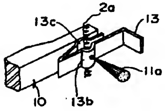

Figure 5